



## Global Warming

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## About The Site

The EPA Global Warming Site is provided as a public service by the U.S. Environmental Protection Agency. EPA's climate change programs and activities are an integral part of the Agency's [mission and purpose](#). With the Global Warming Site, we strive to present accurate information on the very broad issue of climate change and global warming in a way that is accessible and meaningful to all parts of society – communities, individuals, business, public officials and governments.

The United States has based its climate change policies on the conclusions of the [Intergovernmental Panel on Climate Change](#) (IPCC), which has provided an authoritative international consensus on the science of climate change. Content presented on the Global Warming Site relies heavily on the IPCC literature, as well – particularly the [reports](#) listed below.

The United States, the International Community, and the Global Warming Site also rely on the work of the [U.S. Global Change Research Program](#) (USGCRP). In fact, the USGCRP provides a major contribution to the research base on which the IPCC assessments rely. In addition, the Site uses reports related to climate change that have been produced by or for the Agency over the years; many of these reports are available within the Site's [Publications](#) section.

Enjoy this [award-winning](#) Site and we will continue to present or direct you to the most accurate and timely social, scientific, and logistic information available on the global warming issue.

## What is the IPCC?

Recognizing the problem of potential global climate change the World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP) established the [Intergovernmental Panel on Climate Change](#) [EXIT disclaimer](#) in 1988. It is open to all members of the UNEP and WMO.

The role of the IPCC is to assess the scientific, technical and socio-economic information relevant for the understanding of the risk of human-induced climate change. It does not carry out new research nor does it monitor climate related data. It bases its assessment mainly on published and peer reviewed scientific technical literature.

The IPCC has three working groups:

- Working Group I assesses the scientific aspects of the climate system and climate change.
- Working Group II addresses the vulnerability of socio-economic and natural systems to climate change, negative and positive consequences of climate change, and options for adapting to it.
- Working Group III assesses options for limiting greenhouse gas emissions and otherwise mitigating climate change.

## Select IPCC Reports

- IPCC 2001: [Climate Change 2001: The Scientific Basis](#). [EXIT disclaimer](#) Contribution of Working Group I to the Third Assessment Report of the Intergovernmental Panel on Climate Change [Houghton, J.T., Y. Ding, D.J. Griggs, M. Noguer, P.J. van der Linden, X. Dai, K. Maskell, and C.A. Johnson (eds.)]. Cambridge University Press, United Kingdom and New York, NY, USA, 881 pp.
- IPCC 2001: [Climate Change 2001: Impacts, Adaptation, and Vulnerability](#). [EXIT disclaimer](#) Contribution of Working Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change [McCarthy, J.J., O.F. Canziani, N.A. Leary, D.J. Dokken and K.S. White (eds.)]. Cambridge University Press, United Kingdom and New York, NY, USA, 1032 pp.
- IPCC 2001: [Climate Change 2001: Mitigation](#). [EXIT disclaimer](#) Contribution of Working Group III to the Third Assessment Report of the Intergovernmental Panel on Climate Change [Metz, B., O. Davidson, R. Swart and J. Pan (eds.)]. Cambridge University Press, United Kingdom and New York, NY, USA, 752 pp.
- [The Regional Impacts of Climate Change – An Assessment of Vulnerability](#) (1998). [EXIT disclaimer](#) A Special Report of IPCC Working group II. R.T. Watson, M.C. Zinyowera, and R.H. Moss (Eds). Cambridge University Press, UK. pp 517.

## What is the USGCRP?

The [U.S. Global Change Research Program](#) [EXIT disclaimer](#) was formally established by Congress in 1990 to coordinate the resources and research activities of a dozen federal agencies, especially national research activities and U.S. participation in international research activities supporting programs such as the World Climate Research Programme, the International Geosphere-Biosphere Programme, and the Human Dimensions Programme. The USGCRP coordinates a broad agenda of research, supporting the Mission to Planet Earth, ozone depletion studies, and work on the human dimensions of global change. Questions that drive the USGCRP's climate change research include:

- What is the climate's response to increasing concentrations of aerosols and greenhouse gases?
- What are the impacts of climate change on society and the environment?
- How can society mitigate future climate change or adapt to its consequences?

Based on these questions, research focuses on observing and documenting Earth system behavior; understanding the processes that influence changes in the Earth system; developing and applying models to predict climate change; evaluating the effects of climate change on agriculture, forests, water resources, coastal regions, ecosystems, and other natural resources; and improving the capabilities to mitigate adverse consequences and capitalize on any beneficial opportunities

#### Recent Accomplishments of the USGCRP

- Climate models successfully simulated the transient cooling of the lower atmosphere in response to the sulfates emitted by the eruption of Mt. Pinatubo.
- The improved ability to forecast El Niño and resulting shifts in tropical and subtropical precipitation is helping farmers in North and South America to plan better and thereby boost yields and reduce economic disruptions.
- Model simulations of changes in climate over the last 100 years match observed patterns more closely when both greenhouse gases and the regional concentrations of sulfate aerosols are taken into account.
- Combined satellite and surface measurements recently identified an unexpected absorption of 25-40 watts per square meter of radiation by the atmosphere. This new information will lead to a reanalysis of the Earth's radiation balance and the role of clouds in climate change.
- Observations show that since 1970, precipitation over the U.S. has increased by about 5 percent compared with the previous 70 years, primarily in the autumn. In addition, the frequency of extreme rainfall events (more than 2" per day) has increased throughout much of the country.
- Arctic ecosystems exposed to elevated levels of carbon dioxide only increased productivity for a few years, suggesting that the CO<sub>2</sub> fertilization effect may be short-lived.

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## U.S. Environmental Protection Agency

# Global Warming - Climate

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### See Also

[National Academy of Sciences - Climate Change Science: An Analysis of Some Key Questions](#)(305 KB)

Like many fields of scientific study, there are uncertainties associated with the science of global warming. This does not imply that all things are equally uncertain. Some aspects of the science are based on [well-known](#) physical laws and documented trends, while other aspects range from '[near certainty](#)' to '[big unknowns](#).'

### What's Known for Certain?

Scientists know for certain that human activities are changing the composition of Earth's atmosphere. Increasing levels of greenhouse gases, like carbon dioxide (CO<sub>2</sub>), in the atmosphere since pre-industrial times have been well documented. There is no doubt this atmospheric buildup of carbon dioxide and other greenhouse gases is largely the result of human activities.

It's well accepted by scientists that greenhouse gases trap heat in the Earth's atmosphere and tend to warm the planet. By increasing the levels of greenhouse gases in the atmosphere, human activities are strengthening Earth's natural greenhouse effect. The key greenhouse gases emitted by human activities remain in the atmosphere for periods ranging from decades to centuries.

A warming trend of about 1°F has been recorded since the late 19th century. Warming has occurred in both the northern and southern hemispheres, and over the oceans. Confirmation of 20th-century global warming is further substantiated by melting glaciers, decreased snow cover in the northern hemisphere and even warming below ground.

### What's Likely but not Certain?

Figuring out to what extent the human-induced accumulation of greenhouse gases since pre-industrial times is responsible for the global warming trend is not easy. This is because other factors, both natural and human, affect our planet's temperature. Scientific understanding of these other factors – most notably natural climatic variations, changes in the sun's energy, and the cooling effects of pollutant aerosols – remains incomplete.

Nevertheless, the [Intergovernmental Panel on Climate Change](#) (IPCC) stated there was a "discernible" human influence on climate; and that the observed warming trend is "unlikely to be entirely natural in origin." In the most recent Third Assessment Report (2001), IPCC wrote "There is new and stronger evidence that most of the warming observed over the last 50 years is attributable to human activities."

In short, scientists think rising levels of greenhouse gases in the atmosphere are contributing to global warming, as would be expected; but to what extent is difficult to determine at the present time.

As atmospheric levels of greenhouse gases continue to rise, scientists estimate average global temperatures will continue to rise as a result. By how much and how fast remain uncertain. IPCC projects further global warming of 2.2-10°F (1.4-5.8°C) by the year 2100. This range results from uncertainties in greenhouse gas emissions, the possible cooling effects of atmospheric particles such as sulfates, and the climate's response to changes in the atmosphere.

The IPCC states that even the low end of this warming projection "would probably be greater than any seen in the last 10,000 years, but the actual annual to decadal changes would include considerable natural variability."

#### **What are the Big Unknowns?**

Scientists have identified that our health, agriculture, water resources, forests, wildlife and coastal areas are vulnerable to the changes that global warming may bring. But projecting what the exact impacts will be over the 21st century remains very difficult. This is especially true when one asks how a local region will be affected.

Scientists are more confident about their projections for large-scale areas (e.g., global temperature and precipitation change, average sea level rise) and less confident about the ones for small-scale areas (e.g., local temperature and precipitation changes, altered weather patterns, soil moisture changes). This is largely because the computer models used to forecast global climate change are still ill-equipped to simulate how things may change at smaller scales. [See the [U.S. Climate](#) section for more detail on [climate models](#).]

Some of the largest uncertainties are associated with events that pose the greatest risk to human societies. IPCC cautions, "Complex systems, such as the climate system, can respond in non-linear ways and produce surprises." There is the possibility that a warmer world could lead to more frequent and intense storms, including hurricanes. Preliminary evidence suggests that, once hurricanes do form, they will be stronger if the oceans are warmer due to global warming. However, the jury is still out whether or not hurricanes and other storms will become more frequent.

More and more attention is being aimed at the possible

link between El Niño events – the periodic warming of the equatorial Pacific Ocean – and global warming. Scientists are concerned that the accumulation of greenhouse gases could inject enough heat into Pacific waters such that El Niño events become more frequent and fierce. Here too, research has not advanced far enough to provide conclusive statements about how global warming will affect El Niño.

### **Living with Uncertainty**

Like many pioneer fields of research, the current state of global warming science can't always provide definitive answers to our questions. There is certainty that human activities are rapidly adding greenhouse gases to the atmosphere, and that these gases tend to warm our planet. This is the basis for concern about global warming.

The fundamental scientific uncertainties are these: How much more warming will occur? How fast will this warming occur? And what are the potential adverse and beneficial effects? These uncertainties will be with us for some time, perhaps decades.

Global warming poses real risks. The exact nature of these risks remains uncertain. Ultimately, this is why we have to use our best judgement – guided by the current state of science – to determine what the most appropriate response to global warming should be.

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## U.S. Environmental Protection Agency

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Please see [EPA's Climate Change site](#) for current information on climate change and global warming. EPA no longer updates EPA's Global Warming Site, but is maintaining this archive for historical purposes. Thank you for visiting the archive of EPA's Global Warming Site.

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